

Relationship between *Penitella penita* (CONRAD, 1837) and Other Organisms of the Rocky Shore

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(Plate 16)

EVANS (1949) AND LEWIS (1953), IN THEIR STUDIES of the English coast, refer to the intertidal animals which live in holes, crevices and other areas, where they are protected from the sun and from desiccation, as the "cryptofauna."

KÜHNELT (1951) suggested the following terminology to describe the fauna of hard marine bottoms: animals living on the surface of rock occupy the epilithion, those partially embedded occupy the mesolithion, and those wholly embedded occupy the endolithion. Since these terms carry more information than 'cryptofauna', they will be used in this paper. The endolithic community is that group of animals inhabiting the endolithion.

The cryptofauna of EVANS (1949) and LEWIS (1953) included a wide assemblage of relatively delicate, mostly filter feeding animals, such as: hydroids, anemones, tunicates, sponges and bryozoans. These authors observe that the cryptofauna is present primarily in areas of exposed limestone which is readily attacked by borers, such as the clam *Hiatella* sp., the polychaete *Polydora ciliata* (JOHNSTON, 1838) and the sponge *Cliona celata* GRANT. The rough surface produced by these borers serves to hold water during low tide periods and provide homes for nestlers. The large burrows of *Hiatella* were usually occupied by a variety of anemones.

Penitella penita is the most numerous and most widely distributed rock borer along the eastern Pacific coast (COAN, 1964; TURNER, 1955). It is found both subtidally and intertidally, on exposed coasts and in protected bays wherever rock of suitable hardness and composition is available (LLOYD, 1897). The boring activity of *P. penita* is primarily responsible for developing the endolithion as a possible habitat. The conical holes drilled by this animal form dwellings for a large number of nestling animals which move into the empty burrows after the pholads' death.

The following observations were made in the course of a general ecological study of *Penitella penita*. The principal area of study was on two intertidal benches near Fossil Point in Coos Bay, Oregon. Observations were also made on animals collected from South Jetty, a jetty protecting the entrance to Coos Bay, and from the north side of Cape Blanco, Oregon.

Relationship between *Penitella penita* and Organisms of the Epilithion

Once the young *Penitella penita* is well established in the rock, there appears to be little interaction between it and organisms of the epilithion, since pholads derive their food and oxygen from the overlying water. However, surface encrustations appear to control to a certain extent the success of settlement.

Settlement on cleared surfaces facing approximately southeast was compared with surfaces facing northeast (Table 1). The former surfaces quickly developed a heavy coating of algae, presumably from the greater exposure to light, whereas the latter surfaces remained relatively free of algae but received a heavy settlement of *Balanus crenatus* BRUGUIÈRE, 1789. The density of *Penitella penita* was greater on the northeast barnacle-encrusted surfaces than on the algae-coated surfaces. This indicates that conditions suitable for settlement of pholads are similar to those for *B. crenatus*. It also seems likely that either algal cover or high light intensity inhibits settlement of both barnacles and pholads. (See NAGABHUSHANAM, 1959 c, 1960; ISHAM *et al.* 1951 on taxis of marine larvae.)

Table 1

Settlement Density as Related to Surface Direction

Area (cm ²)	Number of pholads	Southeast Face algae covered	Northeast Face barnacle covered	Exposure time (months)	Animals per 100 cm ²
50	44		×	2½	88.0
70	3	×		2½	4.3
190	21		×	6½	11.0
350	16	×		6½	4.6
800	353		×	8	44.1
800	157	×		8	19.6

Interference Between Barnacles and Newly Settled Pholads

A certain amount of interference occurs during, and for a short time after settlement between young pholads and barnacles. If a pholad enters the rock close to newly-settled barnacles, it runs a risk of having its entrance occluded by the laterally expanding base of the barnacle. The pholad siphon, however, appears to be able to dissolve the edge of the barnacle and thus distort its symmetry (see Plate 16).

Examples of barnacles completely occluding burrow entrances were also found. The enclosed pholad was, of course, dead. It is not known whether the barnacle covered the entrance hole before or after the death of the clam.

Botula californiensis (PHILIPPI, 1847), inhabiting the mesolithion, interferes with *Penitella penita* by settling in burrow entrances or boring laterally into burrows. The interference caused is sometimes enough to kill *P. penita*.

The only animal that has been observed to prey on *Penitella penita* at both Fossil Point and South Jetty is the flatworm *Stylochus* sp. PEARSE & WHARTON (1938) report that *S. inimicus* (PALOMBI, 1931) is a predator of oysters. *Stylochus* can enter remarkably narrow pholad holes. For example, a flatworm about 32 mm by 16 mm

was found inside a burrow, the entrance of which was only 1.8 mm in diameter. *Stylochus* consumes the flesh of *Penitella* and leaves the valves in place. It often lays eggs on the inside of the burrow and valves.

The empty burrows left after the death of pholads are filled by a number of nestling animals, which make up the remainder of the endolithic community.

At Fossil Point the empty burrows become filled with sand and mud. Most of the silt-filled burrows are occupied by a terebellid worm, *Thelepus* sp., and its commensal scale worm, *Halosydna brevisetosa* KINBERG, 1855. *Thelepus* appears to extract CaCO₃ from the pholad valves and deposit at least part of it as a chalky layer on the inside of its parchment burrow. The valves of the dead pholad are gradually dissolved completely.

Occasionally bivalves, such as *Tresus nuttallii* (CONRAD, 1837), *Petricola carditoides* CONRAD, 1837, *Macoma nasuta* (CONRAD, 1837) and *Irus lamellifer* (CONRAD, 1837) are found nestling in pholad burrows at Fossil Point. ADDICOTT (1963) found fossil *Tresus nuttallii* nestling in *Penitella penita* burrows in rock of late Pleistocene age.

Just as the epifauna on exposed rocky shores is richer and more varied than in the muddy bays, so too the endolithic community in rocks exposed to the open ocean is more diverse.

Empty burrows exposed to the open ocean are very seldom mud or sand filled. No attempt was made to compile a complete list of organisms occupying this habitat, but the obvious forms were collected and identified (Table 2). On the open coast, 25 taxa were observed as compared with 9 at Fossil Point.

DISCUSSION

The position of the pholad in the littoral community can be compared to that of the woodpecker in the forest community. Both are capable of boring holes in substrates that cannot be worked by other members of the community. In both cases the burrow is used only once, by its originator, and is thereafter left open for a variety of hole or crevice dwellers. In the absence of marine rock borers the endolithic community will not develop. The variety of animal species whether epi-, meso-, or endolithic, on the rocky shore is greatly enhanced by the presence of borers.

Table 2

Nestlers Inhabiting Vacated Pholad Burrows

Open Coast	Fossil Point	Major Taxa	Species
×		Coelenterata	<i>Anthopleura artemisia</i> (PICKERING in DANA, 1848)
	×		<i>Diadumene leucolena</i> (VERRILL, 1866)
×	×	Annelida	<i>Thelepus</i> sp.
×	×		<i>Halosydna brevisetosa</i> KINBERG, 1877
×			<i>Serpula</i> sp.
×			<i>Eupolymnia heterobranchia</i> (JOHNSON)
×			<i>Ramex</i> sp.
×			<i>Pista elongata</i> MOORE, 1909
×			<i>Schizobranchia</i> sp.
×			<i>Distylia</i> sp.
×			<i>Idanthersus</i> sp.
×			<i>Demonax</i> sp.
×		Sipunculoidea	<i>Phascolosoma agassizii</i> KEFERSTEIN, 1866
×			<i>Dendrostomum pyroides</i> CHAMBERLIN, 1919
×		Crustacea	<i>Pachycheles rudis</i> STIMPSON, 1859
×			<i>Oedignathus inermis</i> (STIMPSON, 1860)
×			<i>Spirontocaris palpator</i> (OWEN, 1839)
×			<i>Betacus harfordi</i> (KINGSLEY, 1878)
×		Mollusca	<i>Crepidula nummaria</i> GOULD, 1846
	×		<i>Irus lamellifer</i> (CONRAD, 1837)
×			<i>Trimusculus reticulatus</i> (SOWERBY, 1835)
	×		<i>Tresus nuttallii</i> (CONRAD, 1837)
	×		<i>Petricola carditoides</i> CONRAD, 1837
×	×		<i>Macoma nasuta</i> (CONRAD, 1837)
×			<i>Protothaca staminea</i> (CONRAD, 1837)
×			<i>Entodesma saxicola</i> (BAIRD, 1863)
×	×		<i>Saxicava</i> sp.
×			<i>Kellia suborbicularis</i> (MONTAGU, 1804)
	×		<i>Botula californiensis</i> (PHILIPPI, 1847)
×		Urochordata	<i>Pyura haustor</i> (STIMPSON, 1864)

LITERATURE CITED

ADDICOTT, WARREN O.

1963. An unusual occurrence of *Tresus nuttalli* (CONRAD).
(Mollusca: Pelecypoda) The Veliger 5 (4): 143-145;
3 Text figs. (1 April 1963)

CLAPP, WILLIAM F. & ROMAN KENK

1963. Marine borers: an annotated bibliography. Office Nav.
Res., Dept. Navy, Washington, D. C., pp. 1136

COAN, EUGENE VICTOR

1964. The Mollusca of the Santa Barbara County area. Part
I.—Pelecypoda and Scaphopoda. The Veliger 7(1): 29-33.
(1 July 1964)

CONRAD, TIMOTHY ABBOTT

1837. Descriptions of new marine shells from Upper California,
collected by Thomas Nuttall, Esq. Journ. Acad. Nat. Sci.
Philadelphia 7: 227-268; pls. 17-20 (21 November 1837)

Explanation of Plate 16

The distorted edge of the central barnacle is caused by the young
pholad siphon which emerged from the hole at the right. The siphon
may have the ability to dissolve CaCO_3 .

